THE GASTRIC SECRETION.

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Perhaps no one field in physiological or pathological chemistry contains more of interest than the results of a systematic investigation of the gastric secretion. This paper is based on a study of the vomitus from 81 patients, mostly derived from postanesthetic vomiting. No food particles were present in any of the specimens, for in Mount Sinai Hospital, as in other institutions, food and water are withheld for several hours before the patient is anesthetized. The results, as one can see from the tables, are of some interest and at some variance with opinions held by other observers.

Taking up the first of the columns, we find that the amounts vary from 20 c.c. to 240 c.c. This variance unquestionably is an individual one dependent on the length of the anesthesia, thereby influencing the amount of mucus swallowed, the watery element acting as a chemical stimulant; the psychical effect of both operation and anesthesia, the nervous temperament, etc., of the patient, all or each of which may influence the amount of gastric secretion. Larger amounts of gastric secretion may also be due to an existing functional condition or to a transudation following an abnormal resorptive power. Normally the fasting stomach may contain 10 to 20 c.c. of fluid.

The color question was also of interest: it was brown in 22, green in 37, colorless in 6, yellow in 7, gray in 8. Very few were perfectly clear, mostly all being turbid from the mucus present. Of the 37 green specimens, only 32 contained bile, thus confirming the opinion that not every green stomach contents is caused by the presence of bile. Mucus in various amounts is also influenced by some of the causes which tend to increase the amount of gastric secretion. It may be caused by mouth lesions—stomatitis, ptyalism, pharyngitis, etc. —or by a catarrhal gastritis. Normally, there is always a little mucus present. In 6 there was no mucus, little in 37, moderate in 13, and much in 25.

The normal chemical reaction of the gastric secretion is acid, due to the presence of free acid, partly to acid salts (monophosphates), and partly to both. In the 81 specimens, 66 were acid to litmus, 9 were alkaline, and 5 were neutral.

The Congo paper reaction was positive in but 27 and negative in 53. This reaction is very generally used to determine the presence of free acids, and one is somewhat struck by the fact that 66 of the specimens were acid to litmus and but 27 of these positive to Congo, assuming that the gastric acidity is due to the free acids present.

TABLE I.

Case No.	Diagnosis.	Amount c.c.	Color.	Mucus.	Reaction.	Congo.	Bile.	Total nitrogen per cent.	Ammonia per cent.	Chlorine per cent.
1	Colporrhaphy	32	....	None	...	.....	Negative	0.168	0.018	0.231
2	Carcinoma of kidney	95	Brown	None	Acid	Negative	Negative	0.147	0.008	0.277
3	Endometritis	120	Yellow	Little	Acid	Negative	Positive	0.104	0.017	0.422
4	?	22	Yellow	Little	Neutral	Negative	Negative	0.073	0.0017	0.177
5	Pregnancy	31	Green	Little	Acid	Negative	Positive	....	0.015	0.419
6	Abortion	29	Brown	Little	Acid	Negative	Positive	0.148	0.015	0.397
7	Diseased appendages	88	Brown	Little	Acid	Positive	Negative	0.241	0.029	0.500
8	Renal colic	29	Colorless	Little	Alkaline	Negative	Negative	0.133	0.0204	0.256
9	Tumor of colon	65	Brown	Little	Acid	Positive	Positive	0.172	0.0204	0.497
10	Hemorrhoids	38	Brown	Much	Acid	Negative	Negative	0.246	0.035	0.532
11	Chronic nephritis	68	Brown	Little	Acid	Positive	Negative	0.199	0.029	0.536
12	Hemorrhoids	28	Green	Little	Acid	Negative	Positive	0.256	....	0.653
13	Ectopic gestation	94	Brown	Little	Alkaline	Negative	Negative	0.133	....	0.266
14	Carcinoma of rectum	50	Colorless	Much	Acid	Negative	Positive	0.014	0.030	0.401
15	Hernia	45	Colorless	Much	Acid	Negative	Positive	0.165	0.027	0.348
16	Appendicitis	46	Yellow	None	Alkaline	Negative	Positive	0.095	0.058	0.358
17	Cholelithiasis	102	Yellow	Little	Neutral	Negative	Negative	0.035	0.006	0.099
18	?	90	Colorless	Much	Acid	Negative	Positive	0.143	....	0.419
19	Appendicitis	25	Brown	None	Alkaline	Negative	Positive	0.201	0.054	0.398
20	?	60	Brown	None	Acid	Positive	Negative	0.145	....	0.344
21	Cholecystectomy	50	Green	Little	Acid	Positive	Positive	0.090	0.024	0.440
22	?	240	Gray	None	Neutral	Negative	Positive	0.123	0.036	0.277
23	?	150	Green	Little	Acid	Positive	Positive	0.070	0.027	0.270
24	?	64	Brown	Little	Acid	Positive	Negative	0.160	0.030	0.866
25	Appendicitis	60	Brown	Small	Acid	Positive	Negative	0.140	0.023	0.472
26	Ventral hernia	90	Green	Much	Acid	Negative	Positive	0.154	0.014	0.284
27	Hematoma	22	Green	Much	Acid	Negative	Positive	0.132	....	0.341
28	Appendicitis	77	Green	Moderate	Acid	Negative	Positive	0.199	0.018	0.124
29	Carcinoma of rectum	72	Green	Much	Acid	Negative	Positive	0.238	0.034	0.479
30	Appendicitis	67	Green	Much	Acid	Negative	Positive	0.126	0.017	0.238
31	Appendicitis	30	Green	Much	Acid	Negative	Positive	0.126	....	0.312
32	Glands of neck	53	Brown	Moderate	Acid	Positive	Positive	0.157	0.022	0.415
33	Nephropexy	32	Green	Moderate	Acid	Negative	Positive	0.104	0.010	0.405
34	Appendicitis	160	Green	Much	Acid	Negative	Positive	0.104	0.017	0.287
35	Tumor of breast	45	Green	Much	Acid	Positive	Positive	0.115	0.019	0.394
36	Appendicitis	36	Green	Little	Neutral	Negative	Positive	0.132	0.046	0.373
37	Carcinoma of rectum	67	Brown	Little	Acid	Positive	Positive	0.168	0.025	0.465
38	Salpingo-oöphorectomy	28	Green	Little	Acid	Negative	Negative	0.081	0.007	0.145
39	Appendicitis	80	Brown	Much	Acid	Positive	Negative	0.036	0.012	0.433
40	Appendicitis	21	Green	Little	Acid	Positive	Positive	0.056	....	0.298
41	Gall-bladder	20	Brown	Little	Acid	Positive	Negative	0.362	....	0.454
42	Appendicitis	65	Green	Moderate	Acid	Negative	Positive	0.082	0.019	0.252
43	Tuberculous glands	52	Green	Moderate	Acid	Negative	Positive	0.244	0.034	0.366
44	Hernia	32	Colorless	Little	Acid	Negative	Positive	0.120	0.003	0.383
45	Appendicitis	78	Green	Much	Acid	Negative	Positive	0.210	0.012	0.273
46	Hernia	124	Green	Moderate	Acid	Negative	Positive	0.178	0.020	0.398
47	Ovarian cyst	68	Green	Much	Acid	Positive	Negative	0.193	0.019	0.383
48	Gastrostomy	65	Brown	Little	Acid	Negative	Positive	0.134	0.012	0.128
49	Appendicitis	85	Gray	Little	Acid	Negative	Positive	0.087	0.017	0.145
50	Appendicitis	95	Green	Mucus	Acid	Positive	Positive	0.154	0.018	0.348
51	Glands of neck	45	Brown	Little	Acid	Negative	Negative	0.224	0.039	0.539
52	Gall-bladder	140	Green	Much	Acid	Negative	Positive	0.120	0.025	0.351
53	Appendicitis	43	Green	Little	Acid	Positive	Positive	0.145	0.023	0.532
54	Appendicitis	40	Gray	Moderate	Alkaline	Negative	Positive	0.249	0.044	0.490
55	Fistula-in-ano	30	Yellow	Moderate	Acid	Negative	Positive	0.134	....	0.131
56	Varicose veins	36	Gray	Little	Alkaline	Negative	Positive	0.210	0.017	0.436

TABLE I—*Continued.*

Case No.	Diagnosis.	Amount c.c.	Color.	Mucus.	Reaction.	Congo.	Bile.	Total nitrogen per cent.	Ammonia per cent.	Chlorine per cent.
57	Abdominal cyst	34	Green	Much	Acid	Positive	Negative	0.098	0.041	0.571
58	Hernia	51	Green	Little	Acid	Positive	Positive	0.176	0.019	0.678
59	Appendicitis	25	Green	Much	Acid	Negative	Positive	0.087	....	0.224
60	Appendicitis	75	Green	Little	Alkaline	Negative	Positive	0.143	0.014	0.366
61	Tumor of breast	50	Green	Little	Alkaline	Negative	Positive	0.143	0.020	0.327
62	Appendicitis	90	Brown	Little	Acid	Positive	Positive	0.263	0.029	0.437
63	Appendicitis	60	Colorless	Moderate	Acid	Positive	Positive	0.148	0.015	0.408
64	Appendicitis	40	Green	Much	Acid	Negative	Positive	0.109	0.017	0.412
65	Salpingo-oöphorectomy	50	Brown	Moderate	Acid	Positive	Positive	0.146	0.015	0.344
66	Appendicitis	60	Green	Little	Acid	Negative	Positive	0.140	0.017	0.415
67	Cholecystectomy	70	Brown	Much	Acid	Positive	Negative	0.148	0.019	0.284
68	Hemorrhoids	78	Brown	Little	Acid	Positive	Positive	0.137	0.020	0.387
69	Hemorrhoids	63	Green	Much	Acid	Negative	Positive	0.134	0.036	0.366
70	Hemorrhoids	37	Green	Little	Acid	Positive	Positive	0.120	0.036	0.415
71	Umbilical hernia	70	Gray	Moderate	Acid	Negative	Positive	0.120	0.036	0.437
72	Colostomy	70	Yellow	Much	Acid	Negative	Negative	0.216	0.017	0.383
73	Gall-bladder	70	Green	Little	Acid	Negative	Positive	0.109	0.031	0.412
74	Bunion	43	Gray	Moderate	Acid	Negative	Negative	0.129	0.027	0.380
75	Hernia	31	Green	Little	Neutral	Negative	Negative	0.193	0.036	0.621
76	Hemorrhoids	41	Gray	Little	Alkaline	Negative	Negative	0.182	0.032	0.366
77	Hernia	95	Green	Much	Acid	Negative	Positive	0.117	0.013	0.398
78	Appendicitis	80	Brown	Moderate	Acid	Positive	Positive	0.098	0.012	0.348
79	Osteomyelitis	80	Gray	Much	Acid	Negative	Positive	0.174	0.029	0.330
80	Appendicitis	30	Green	Much	Acid	Positive	Negative	0.140	....	0.479
81	Hernia	31	Gray	Little	Acid	Negative	Negative	0.160	0.030	0.465
							Average	0.147	0.022	0.378

Ratio of ammonia to total nitrogen, 1 to 6.6. Total of nitrogen to chlorine, 1 to 2.6.

This result points to a conclusion that Congo paper is hardly sensitive enough to rely on even for a qualitative test, and to use instead, according to Leo, a solution of Congo red, which is much more delicate than the paper. He shows that while Congo paper gave a positive reaction when 0.01 per cent. HCl was present, a solution of Congo red gave a positive reaction with but 0.0009 per cent. HCl.

The presence of bile in 56 of the specimens and its absence in 25 was rather interesting. Bile in the gastric secretion occurs as a regurgitation into the stomach—frequently seen in the vomitus whenever the vomiting may be very intense or frequently repeated. The presence of bile, ever so faint, signifies an antiperistalsis of the duodenum. Larger amounts of bile point to a deficient stomach motility, an atony, or an ectasia. Schüler even says that large amounts of bile aid in making a differential diagnosis between an atonic ectasia and an ectasia due to a pyloric stenosis, being much larger in amount in the former.

The passage of bile into the stomach during digestion seems, according to several observers, to have no disturbing action on gastric digestion. The acid contents of the stomach, containing an abundance of proteins, gives with the bile a precipitate of proteins and bile acids. The precipitate formed easily redissolves in an excess of bile, and also in the NaCl formed by the neutralization of the HCl of the gastric juice. This may take place even in a faintly acid reaction.

The chemical reaction of bile is feebly alkaline, and when in the stomach unquestionably neutralizes the HCl, and this perhaps accounted for the small number of Congo positive reactions. Of the 27 positive Congo reactions, 16 showed the presence of bile; of the 53 negative Congo reactions 40 showed the presence of bile.

From this it can be assumed that, while the bile has but little influence on the acid reaction to litmus, it does appear to have some effect on the Congo reaction. There were but 9 cases in which the reaction was alkaline, and in 6 of these bile was present. In these 6 cases the chlorine percentage was comparatively high, while in the other 3, in which bile was absent, this percentage was low.

The percentage of total nitrogen varied from 0.014 to 0.362, the average being 0.147. In recent years more attention has been given to the nitrogen content of the gastric secretion, particularly by Salomon for the purpose of diagnosticating carcinoma of the stomach. He maintained that if in 100 c.c. of normal salt solution used to rinse out the empty stomach, he found more than 25 mg. of total nitrogen, it indicated the presence of a carcinoma. In none of the patients from whom the specimens were obtained was carcinoma diagnosticated, thereby preventing confirmation of his opinion.

Ammonia in the stomach secretion is regarded by some as a pathological constituent, by others (Rosenheim and Strauss) as normal. In each of the 81 specimens the ammonia content was a fairly constant one, as will be seen from the table—an average of 0.022 per cent.

Chlorine, a normal component of the gastric juice, is a most important element for the formation of the HCl. How this acid is formed we are not at all certain. According to the older observers, the amount of chlorine present in gastric juice is more than would suffice to form chlorides with all the bases present, and the excess, if regarded as existing in the form of HCl, corresponds exactly to the amount of free acid present. At some subsequent time I shall publish results on this question.

Looking at the chlorine figures, it can be seen that these vary considerably. Realizing that chlorine enters materially into the quantity of HCl formed, we find that a positive Congo reaction was obtained when there was 0.27 per cent. or upward of chlorine.

Although 60 of the cases showed the presence of more than 0.30 per cent. chlorine, the Congo reaction was positive in 24 and negative in 36. Of the positive ones, bile was present in 14 and absent in 10. Of the 36 negative cases, bile was present in 29 and absent in 7. From this we may be permitted to conclude that the bile present in some way acts on the chlorine and hence gives a negative Congo reaction. This appears to indicate that bile in the stomach—how frequently it is present we can not say, because we assume it is only present as a result of vomiting or in pathological conditions—influences the acidity, and may be used therapeutically in cases of hyperacidity with at least similar or perhaps better results than attend the use of alkalies. At present I am engaged in a study of this question, and in a subsequent communication will give my results.

In making studies on the total nitrogen, ammonia, and chlorine contents of the gastric juice, one must not lose sight of the saliva factor. To allow for this, I examined these elements in ten normal salivas.

TABLE II.—SALIVA.

No.	Total nitrogen.	Ammonia.	Chlorine.
1	0.0616 per cent.	0.0085 per cent.	0.0568 per cent.
2	0.0504 per cent.	0.0085 per cent.	0.0852 per cent.
3	0.0658 per cent.	0.0238 per cent.	0.0816 per cent.
4	0.0546 per cent.	0.0187 per cent.	0.0461 per cent.
5	0.0826 per cent.	0.0255 per cent.	0.0994 per cent.
6	0.0546 per cent.	0.0120 per cent.	0.0460 per cent.
7	0.0434 per cent.	0.0050 per cent.	0.0710 per cent.
8	0.0364 per cent.	0.0170 per cent.	0.1171 per cent.
9	0.0546 per cent.	0.0170 per cent.	0.0532 per cent.
10	0.0644 per cent.	0.0153 per cent.	0.0710 per cent.
Average	0.0568 per cent.	0.0151 per cent.	0.0727 per cent.

Ratio of ammonia to total nitrogen, 1 to 3.76. Total of nitrogen to chlorine, 1 to 2.28.

From these ten cases an average was obtained for comparison with the same constituents of the gastric secretion, and it will be noticed that the total nitrogen in the latter is almost three times that of the saliva, the ammonia twice, the chlorine more than five times.

To Dr. S. Bookman, thanks are due for many suggestions in the course of this study.